SPoRT Assessment Report for NOAA Satellite Proving Ground: Impact of the 24-hour Microphysics RGB Imagery for Alaska Aviation Forecasts of Low Clouds during Summer 2015

Introduction

An assessment was conducted from June 15 to August 7 by NASA/SPoRT in collaboration with operational forecasters in Alaska WFOs regarding the use of multi-spectral (i.e. RGB) imagery from VIIRS (NPP) and MODIS (Aqua & Terra) as a proxy to future JPSS and GOES satellite missions for the purpose of improving analysis of low ceiling and visibility hazards to aviation users for use in nowcasts/forecasts (i.e. TAFs). This assessment is part of NASA/SPoRT activities within NOAA's Satellite Proving Ground (GOES-R/JPSS) to demonstrate new capabilities and provide user feedback to product developers on the impact within operations. The products being assessed were the Nighttime Microphysics (NtMicro) and the 24-hr Microphysics (24hr Micro) multi-spectral composite (i.e. RGB) imagery.

The 24hr Micro. RGB is very similar to the NtMicro. RGB except the green component uses the 11-8.7µm channel difference vs the 11-3.9 µm channel difference (Table 1). This eliminates the 3.9 µm issues related to solar reflectance influence during the day as well as the increased "noise" of the channel in very cold scenes. However, the 8.7µm channel is not as sensitive to changes in cloud phase as the 3.9 µm and therefore can have less contrast in resulting RGB color between varying cloud types.

Color	NtMicro RGB (µm)	24hr Micro RGB (µm)
Red	12.0-10.8	12.0-10.8
Green	10.8-3.9	10.8 – 8.7
Blue	10.8	10.8

Table 1. Channel/Differences used for RGBs

There's also a different "stretch" of the green component to help this issue, but some adjustment for high latitude application of this stretch may yet be a task to examine. The RGB provides a more efficient way to use 3 infrared bands to perform cloud analysis of all types, but the focus here continued to be low cloud and fog features that pose a safety hazard to the aviation community, which are highlighted in ceiling and visibility forecasts within the TAF product. Changes to the 24hr Micro RGB that enhance the ability to find and characterize these hazards are a possible result of this assessment.

Additionally, an objective of this assessment was to determine the impact of the 24hr Micro RGB during long periods of daylight in Alaska when the NtMicro RGB would not be valid. Much of the assessment period had 18 hours of daylight where the NtMicro RGB would be unusable. This assessment is a follow-on to that conducted in the January to March 2015 period where forecasters were able to compare the two RGBs side-by-side to better learn how to interpret the 24hr Micro RGB in preparation for this summer assessment. Forecasters were familiar with the NtMicro RGB and had found it to be a valuable tool for fog and low cloud analysis in the prior winter season.

User feedback during the winter assessment indicated that the impact of the 2 RGBs were nearly equal overall, although some events showed the NtMicro RGB to be notably more desired. A slight modification to the EUMETSAT 24hr Micro. RGB recipe had been used in winter, but this summer assessment utilized the original 24hr Micro. recipe for both MODIS and VIIRS

instruments. In addition limb and bias corrections were applied to individual channels prior to the RGB construction in order to better compare RGBs from differing imager hardware. The data for the RGBs in Alaska came from the Direct Broadcast stations operated by the Geographical Information Network of Alaska (GINA) at the University of Alaska Fairbanks which ingest both MODIS and VIIRS data. NASA/SPoRT created the RGB imagery locally via GINA-provided virtual machines and distributed the data files using Local Data Manager (LDM) software to NWS WFOs for use in AWIPS I and II. About a 30-45 minute latency exists by the time the data is in the users display system. Forecasters were able to examine the RGB imagery in conjunction with other data, and they provided feedback to SPoRT on the impact of this data to operations by filling out a "2-minute feedback" form online as well as an assessment "wrap-up" questionnaire.

User Feedback

All three Alaska WFOs participated in the assessment with a total of 28 events evaluated (17 Fairbanks, 5 Anchorage, 6 Juneau). Overall the majority of forecasters indicated the 24hr Micro. RGB had "Some" to "Large" impact (Figure 1) to their TAFs.

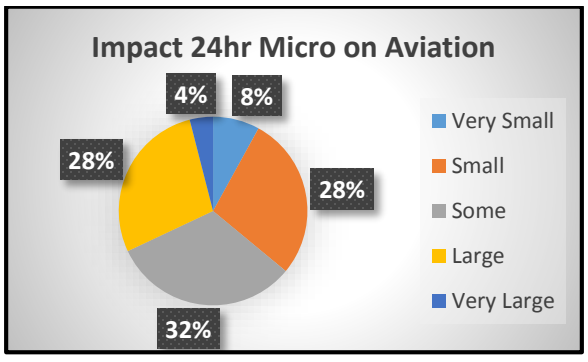

Figure 1. User feedback ranking the "impact" to operational forecasts from the 24-hr Microphysics RGB product.

Very similar results occurred for the NtMicro RGB impact to aviation except there was slightly higher percent for the "Large" to "Very Large" categories and slightly lower percent for the "Small category

These bullets are a short summary of the forecaster feedback received via the online form regarding the impact of the two RGBs:

- There were 15 day cases, 11 night, and 2 with cloud objects of interest near the terminator
- Impact of the 2 RGBs to aviation in the day was ranked very similarly.
- Impact at night to aviation had the NtMicro RGB ranked higher.
- The NtMicro had no impact rankings of "Small" in night cases, while the 24hr Micro had 3 such events.
- The 24hr Micro RGB had 7 total cases in the "small" impact category while the NtMicro only had 3.
- The 24hr Micro was rated as more valuable than the NtMicro in 7 cases, but less valuable in 7 other cases.
- Both Public and TAF forecasts were impacted frequently, with occasional impact to marine.
- The RGBs were complimentary to other GEO-based satellite imagery and products.

Forecasters expressed that the RGB training provided by SPoRT was sufficient, but they would like more training in the form of micro-lessons and webinars (i.e. teletraining). There was a mix of feedback when asked if the RGBs provide similar value. Some users recognized the value of the 24hr Micro. RGB during the day when the NtMicro RGB was not valid, but others found the 24hr Micro. RGB hard to interpret due to a lack of color contrast compared to the NtMicro RGB. A few forecasters were also interested in a "daytime microphysics" RGB that might be used opposite the NtMicro RGB. While the value of the 24hr Micro. RGB seemed to be situational dependent, users indicated a desire to continue receiving the product; however, most felt that it was not ready for use by the wider operational community. When asked if

the RGBs are a "regular part of operations", users generally indicate that the NtMicro RGB is regularly examined and applied, but the 24hr Micro RGB is not. Users also expressed a desire for the NtMicro RGB to be developed from the various satellites that carry the AVHRR instrument. There are five other satellites with this capability which would dramatically increase the number of passes available per day and hence, would increase the usage of MODIS and VIIRS versions of these RGBs. Feedback suggests that users feel more prepared for the GOES-R era through these assessment activities and this objective of day-1 readiness would be even further served if RGBs from AVHRR were made available.

Product Impacts and Limitations

The assessment of the NtMicro and 24hr Micro. RGBs focused on the impact to aviation forecast responsibilities. However, user comments and feedback regularly noted that the RGBs impact forecasts in the public and marine areas. The Fairbanks WFO (AFG) applied the RGBs on June 28 to analyze fog impact to roadways in the region between Delta Junction and Fairbanks (Figure 2).

The forecaster commented:

"Valley fog was seen over portions of the deltana and tanana flats (zone 223) and the fortymile country (zone 224) (notably along the Salcha river). Feature of interest was identified with the ~1405 UTC 28-Jun-15 24-hr micro RGB product. Saw this feature with VIIRS day night band and 0.64 micron also with a high-res topo map further confirming it being confined to the valleys."

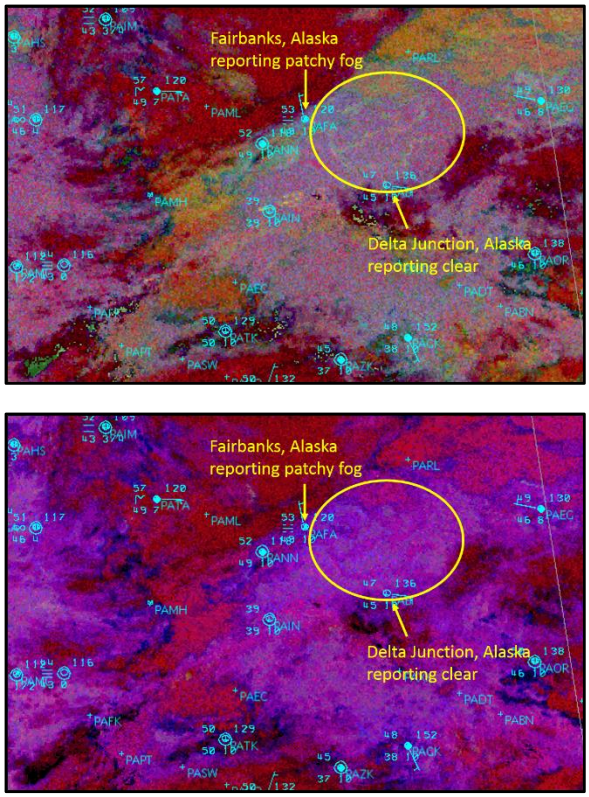

Figure 2. 24hr Micro RGB (upper) and NtMicro RGB (lower) at 1405 UTC (6:05 AM local) 28 June 2015 centered near Fairbanks, AK with observations in station model format.

A typical impact of the 24hr Micro. RGB to the TAF product was provided by the AFG on 12 July 2015 (Figure 3) where the forecaster was able to monitor the progression of a stratus cloud layer that lowered ceilings to IFR conditions and had the confidence to adjust the TAF based on the RGB.

The forecaster commented:

"The stratus on the arctic coast stands out a little on the 12/0524z and 0701z 24hr modis...but really jumps out on the 12/0840z. The stratus over the northern Seward Peninsula, Bering Strait, and Chukchi Sea is also visible. The product was very helpful in determining how far inland the stratus was being pushed by the northeast flow."

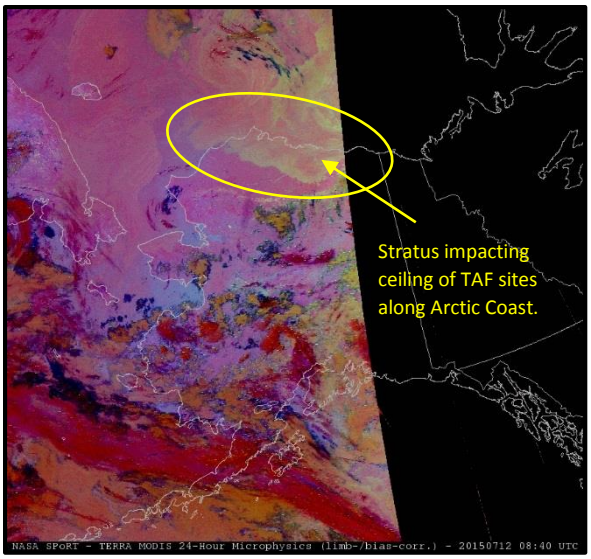

Figure 3. 24hr Micro RGB. at 0840 UTC (12:40 AM local) on 12 July 2015 from Terra MODIS over Alaska.

There were 15 other events where users provided feedback that the RGBs gave them confidence to make adjustments to TAFs.

In other cases, the RGBs showed limitations in their value, particularly for the 24hr Micro. RGB where the color contrast was low compared to the NtMicro RGB. For a daytime, low cloud event with IFR ceilings over the Juneau, Alaska WFO (AJK) area, a forecaster indicated that the newest version of the 24hr Micro. RGB was improved over the past winter product; however, they were more comfortable with other imagery products for the event. On 20 June 2015 several aviation sites within the AJK warning area had IFR ceilings reported, and the 24hr Micro. RGB depicted a uniform cloud feature across the region. The forecaster commented:

"I had better luck picking out the cloud features in the 24-hour microphysics now than I did this past winter, however the colors displayed still make it somewhat difficult to pick out where the cloud edge is compared to using regular visible satellite images or VIIRS 1.61 band."

The shades of color between low and mid clouds as well as land and water features often had subtle differences which lead users to have less confidence in their interpretation and application of the imagery to analyze low clouds and fog.

Conclusions and Recommendations

This first summer evaluation of RGB imagery products in Alaska demonstrated that both products had some to very large impact in roughly two-thirds of the events where the product is examined. The majority of feedback was from the Fairbanks WFO where vast areas are not well seen by traditional GOES imagery due to a low viewing angle. However, all of the Alaska WFOs found benefit when applying the RGBs for cloud analysis related to ceiling and visibility hazards to the aviation community. The NtMicro RGB continued to be used, even within this period where the minimum nighttime hour were occurring due to better color contrast. The 24hr Micro RGB had a mix of small and large impact depending on the event type and the location applied. In general, users were not able to replace the use of the NtMicro with the 24hr Micro RGB, but they continued to apply the 24hr Micro RGB during the day in order to more efficiently see low cloud and fog hazards compared to single channel imagery.

Recommended actions based on this assessment and interactions with forecasters:

- Development of NtMicro and other RGBs via MetOp and NOAA/POES satellites that have AVHRR imager. Users at both high and low latitudes will be more likely to view JPSS data and will be better prepared for GOES-R as a future capability
- Adjustment of 24-hr Micro RGB thresholds to better fit needs of high latitude users
- Development of a library of RGB application examples (regional, seasonal) that can be used as a training aid or reference in operations